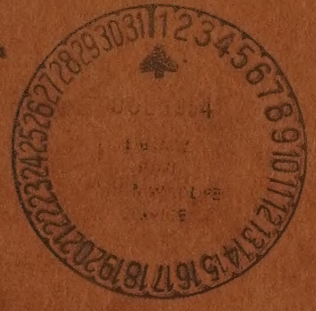
CREEL CENSUS AND EXPENDITURE STUDY, NORTH FORK SUN RIVER, MONTANA, 1951



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SMR 129

Explanatory Note

The series embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for the official use of Federal, State or cooperating Agencies and in processed form for economy and to avoid delay in publication.

57801

INDEX MAP

MONTANA

GREAT FALLS

HELENA

BILLINGS

LEGEND

- State Highway
- Improved Road
- Unimproved Road
- National Forest Boundary
- Wilderness Area Boundary
- Guard or Ranger Station
- Dude Ranch or Resort

Base: Forest Service Map – Lewis & Clark Nat'l. Forest

SCALE IN MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
MISSOURI RIVER BASIN STUDIES

LOCATION MAP
CREEL CENSUS
SUN RIVER
MONTANA

DRAWN: M.E.K. SUBMITTED:
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BILLINGS, MONTANA DEC. 1951 | MO 1-4-3

United States Department of the Interior, Douglas McKay, Secretary
Fish and Wildlife Service, John L. Farley, Director

CREEL CENSUS AND EXPENDITURE STUDY,

NORTH FORK SUN RIVER, MONTANA, 1951

Prepared in the Office of Missouri River Basin Studies
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CREEL CENSUS AND EXPENDITURE STUDY, NORTH FORK SUN RIVER, MONTANA, 1951

A creel census was conducted on the North Fork Sun River and several associated bodies of water in Montana during 1951. This study was part of a general program inaugurated by the Office of Missouri River Basin Studies, Fish and Wildlife Service, to provide information concerning fishing pressure, yield, and comparative worth of various types of fisheries in the Missouri River Basin.

The present paper is concerned with fisherman-expenditures, fisherman-use, and yield of the fisheries involved, although some data on other aspects of the fishery were obtained.

The cooperation of the U. S. Bureau of Reclamation, the U. S. Geological Survey, the U. S. Forest Service, the Montana Fish and Game Department, and the Greenfields Irrigation District in various phases of the work is appreciated.

DESCRIPTION

Waters included in this study were (1) the North and South Forks of the North Fork Sun River (which unite at the head of Gibson Reservoir), (2) the North Fork Sun River between Gibson Dam and Diversion Reservoir, and between Diversion Dam and the confluence of the river with the outlet canal from Willow Creek Reservoir, (3) Gibson Reservoir, (4) Diversion Reservoir, (5) Pishkun Canal, (6) Tunnel Lake, (7) Pishkun Reservoir, (8) Split Rock Lakes, (9) Willow Creek Reservoir, (10) Beaver Creek, and (11) Wood Lake (see map).

Gibson, Diversion, Pishkun, and Willow Creek Reservoirs and Pishkun Canal were constructed by the U. S. Bureau of Reclamation between 1906 and 1911, and are now jointly owned by the Bureau of Reclamation and the Greenfields Irrigation District, a local water-users association.

The North Fork Sun River is on the eastern slope of the Rocky Mountains in Lewis and Clark County and Teton County, Mont. The two main tributaries of the North Fork Sun River, the North and South Forks, flow through mountain valleys which more or less parallel the Continental Divide (fig. 1). From the junction of these main tributaries at the head of Gibson Reservoir, the North Fork Sun River flows easterly for 7 miles through the reservoir, thence 4 miles through a steep, narrow canyon, and then out onto the plains for about 25 miles, where it joins with the South Fork Sun River to form the Sun River, just below the town of Augusta.

Fig. 1.--A typical section of the North Fork of the North Fork Sun River.

The North and South Forks of the North Fork Sun River are medium-altitude streams (about 4,730 feet m.s.l. at their confluence); each has an abundance of pools and riffles and a width of about 60 feet in the lower reaches. Records indicate a marked similarity in the flow of the two streams. In 1951 the combined flow at their confluence reached the maximum in May, when the average flow for the month was 4,253 second-feet. The minimum monthly flow of 304 second-feet occurred in March. These two streams drain an area of about 1,000 square miles. The principal tributaries are Moose Creek on the North Fork and the West Fork on the South Fork, but there are many other named and unnamed tributaries in the drainage. Beaver dams are found on many of the smaller creeks. Although the river below the junction of the two forks has been considerably modified by water-development projects, the tributary streams that originate the North Fork Sun River are essentially in a natural state. The upper slopes of the headwater valleys are characterized by stands of lodgepole pine, Douglas-fir, and spruce. Both streams lie within the Lewis and Clark National Forest. A part of the South Fork and all of the North Fork are within the Bob Marshall Wilderness Area. This headwater area can be reached by boat through Gibson Reservoir, or by hiking or horseback. The North Fork may be reached also by trails entering the area from the headwaters of the Teton River at the Ear Mountain Ranger Station, and

the South Fork may be reached by way of a graded road which terminates at the Bench Mark Ranger Station. Pack trails follow many of the larger tributary streams. The K-L Ranch, with facilities at the confluence of the North and South Forks and on nearby Arsenic Creek, is open to guests throughout the summer.

Gibson Reservoir, on the North Fork Sun River just below the confluence of the two principal tributary streams, is a storage reservoir. It is about 7 miles long and has a maximum width of approximately 1 mile. It has a surface area of 1,360 acres at maximum capacity. The maximum depth is about 180 feet; normally about four-fifths of the reservoir is over 30 feet deep. The reservoir is subject to considerable fluctuation of water level. For example, during the past 6 years, the maximum annual fluctuation was 116 feet (1949) and the minimum was 29 feet (1951). In 1951 the water level dropped 28 feet in August, after having risen more or less consistently.

Gibson Reservoir lies within the Lewis and Clark National Forest, at elevation 4,729 feet. It is surrounded by rocky ridges, partly covered with coniferous growth. It can be reached at the dam by a steep, narrow, rocky road, and is accessible by foot or horseback from a pack trail which skirts the north shore. Boats may be used on the reservoir providing they are at least 14 feet in length and have a beam of 48 inches.

That part of the North Fork Sun River which lies between Gibson Dam and Diversion Reservoir is 3 miles long and about 80 feet wide. Here the river flows through a narrow canyon and is characterized by large, deep pools and turbulent riffles. The flow is regulated by discharge from Gibson Dam. During 1951 the flow varied from 234 second-feet in February to 4,060 second-feet in May; during the study period the flow gradually decreased from the 4,060 second-feet in May to 407 second-feet in September. Several streams, the largest of which is Beaver Creek (about 15 feet wide), enter this reach of the river. All streams entering from the north were closed to fishing, and all on the south side were open to fishing. Of those entering from the south, Beaver Creek was the most extensively used by fishermen. A forest road extends up Beaver Creek a distance of about 2 miles. Large areas of the canyon and adjacent gulches are barren of forest cover because of the rocky terrain and past fires.

Diversion Reservoir, 3 miles downstream from Gibson Reservoir, is a long, narrow, 100-acre impoundment. Water in this reservoir is maintained at a relatively stable level. Diversion Reservoir is in the same canyon as the river between it and Gibson Reservoir and therefore has a similar setting. It is accessible by a road along the south shore.

The 22 miles of the North Fork Sun River (fig. 2), from Diversion

Fig. 2.--North Fork Sun River below Diversion Dam.

Dam to its confluence with the Willow Creek Reservoir outlet canal, was included in the census area. The average width of this reach of stream is about 120 feet, and the gradient is about 18 feet per mile.

Although some of the substantial seepage from Pishkun Canal enters this section of stream through the few small tributaries, the flow is largely controlled by releases from Diversion Reservoir. During water year 1951, the extremes in flow just below Diversion Dam were 234 second-feet in February and 3,526 second-feet in May. Flows of between 3,526 and 1,517 second-feet were maintained during May, June, and July but were dropped to less than 500 second-feet in August, September, October, January, February, and March. Alternate riffles and pools are characteristic of this section of the river. From Diversion Reservoir the river flows through a narrow band of wooded foothills, thence through rolling prairie-type terrain. A fringe of cottonwoods and willows grows along most of the lower river. The upper 3 or 4 miles is accessible by a graded road, while the rest is accessible in all but the most adverse weather by a network of trails.

Pishkun Canal, which carries water from Diversion Reservoir to Pishkun Reservoir, is 12 miles long and has a capacity of 1,200 second-feet. Since the intake to Pishkun Canal is not screened, fish enter the canal from Diversion Reservoir and large numbers are lost when the canal is drained each fall (Fish and Wildlife Service, 1952b). The canal extends through the foothills and into the prairie. A maintenance road parallels the canal throughout its length.

Pishkun Reservoir is an offstream impoundment on the plains about 12 miles northeast of Diversion Reservoir. It has a surface area of 1,550 acres at maximum elevation. The water level in Pishkun remains fairly stable during most of the year, although a rise occurs each year beginning about May. The water level rose about 10 feet in May 1951 and remained fairly stable until July, when it dropped about 5 feet. Maximum and minimum annual fluctuations during the past 7 years were 16 feet (1949) and 9 feet (1946), respectively. Pishkun Reservoir is surrounded by grasslands. It is accessible by ranch roads from Augusta, the maintenance road along Pishkun Canal, and a graded road from Choteau.

Fig. 3.--View of Willow Creek Reservoir showing Willow Creek Dam in foreground.

Willow Creek Reservoir is a 1,400-acre impoundment (fig. 3) on the plains near Augusta, about 15 miles southeast of Gibson Reservoir and about 1 mile off the graded road between Augusta and Diversion Reservoir. Water stored in this reservoir is released, as needed, to satisfy downstream water rights of 300 second-feet for irrigation. Water enters the reservoir from Willow Creek and Willow Creek Feeder Canal, which stems from Pishkun Canal a short distance below Diversion Dam. Willow Creek Feeder Canal has a maximum capacity of 500 second-feet and is 7.5 miles long.

Tunnel Lake, adjacent to Pishkun Canal, about 6 miles from Pishkun Reservoir, is a former pothole. It now has a surface area of about 30 acres and a maximum depth of about 20 feet. Natural runoff into Tunnel Lake is now intercepted by Pishkun Canal, but this is more than replaced by seepage from the canal. The water level rose about 4 feet between May and September in 1951.

The chain of ponds known as Split Rock Lakes also is near Pishkun Canal, about 2 miles above Pishkun Reservoir. Of the many ponds, which are from 3 to 30 acres in size, only 3 or 4 of the largest are fished to any extent. Before the construction of Pishkun Canal, the Split Rock Lakes were shallow potholes with an undependable water supply; seepage from the canal now supplements the normal inflow and assures relatively stable water levels.

There are a few other small lakes in the watershed which provide fishing. Wood Lake, 2 20-acre lake near Bench Mark, is the most important of these. Actually, Wood Lake is on a tributary of the South Fork of the North Fork Sun River. A short creel census was made at Wood Lake during the course of the study. Other lakes in the watershed were censused but, because of limited use, data were included with that for adjacent streams.

Augusta, at the lower extremity of the study area, is the closest town to the study area (see map). Augusta has a population of about 500 people and is a trading point for the local ranchers. Choteau, 26 miles to the north of Pishkun Reservoir, has a population of 1,615, and Great Falls, 60 miles directly east of the study area, has a population of 39,214 (1950 census).

The general area is accessible by State Highway 33 which links Augusta with Helena (75 miles to the south) and Choteau to the north, and by State Highway 20 which connects Augusta with Great Falls. A branch line of the Great Northern Railway terminates at Augusta.

Stock raising is the principal local industry. Some lands are dry-farmed or irrigated. Catering to tourists and sportsmen is an important business in the area, and several resorts and dude ranches are located in the vicinity of the study area. In 1951, there were at least seven dude ranchers who either provided accommodations for guests or packing facilities, or both. Two of these ranchers were located on the main river; one ranch (K-L) was just outside the Wilderness Area at the confluence of the North and South Forks. Others were at Ear Mountain and Bench Mark near the headwaters of the North and South Forks (see map).

Precipitation amounted to 2.95 inches at Augusta and 2.59 inches at Gibson Dam for the period of study, May through September. At the junction of the North and South Forks some rain or snow fell on about 30 percent of the days of this period and about three-fourths of the days were cloudy. Weather conditions were more favorable at the lower elevations. The prevailing winds were westerly and often reached gale strength, especially in the canyon area.

Water temperatures recorded during the study ranged from 34° F. to 58° F. During the early part of the season temperatures below Diversion Dam were slightly higher than those above Gibson Reservoir, but throughout most of the remainder of the season temperatures taken immediately below Diversion Dam and at the junction of the two upper forks were not materially different. Daily temperature recordings were not made in the lower reaches of the North Fork Sun River, but readings taken at occasional intervals indicate that the average water temperature in that area was a few degrees higher than in the upper reaches. The maximum recorded difference in temperatures between the upper and lower reaches was 8° F. Except in the shallow Split Rock Lakes, water temperatures of the reservoirs were similar to those of the streams.

The water in Gibson, Diversion, and Pishkun Reservoirs is in the medium-hard group (73 to 191 p.p.m. $CaCO_3$). As might be expected, the waters of Gibson Reservoir were slightly softer than those of the lower two reservoirs; otherwise, there was little apparent difference in the chemical nature of the waters of the three impoundments.

Rainbow and cutthroat trout were taken in all waters included in the study except the Split Rock Lakes; brook trout were taken in all areas except Pishkun Reservoir and Split Rock Lakes. Grayling were recorded from Pishkun Reservoir and the river below Diversion Dam; single specimens were reported from Gibson Reservoir, the Middle River, and Pishkun Canal 1/.

1/ Although single specimens of grayling were reported from Gibson Reservoir, the Middle River, and Pishkun Canal, there is some doubt about this species occurring in these areas. All these areas are above Diversion Dam, and there is no record of any grayling plants above this point. If the species were native to these areas, it would seem that several specimens would have been checked in creels.

Whitefish were caught in Diversion Reservoir and in sections of the river below Gibson Dam. A few brown trout were caught in Tunnel Lake. Pike (fig. 4), yellow perch, and a single largemouth black bass were recorded from the Split Rock Lakes. Suckers were recorded from all the reservoirs and the upper and lower river. Sculpins were found in most of the waters.

Fig. 4.--Four pike taken from Split Rock Lakes on opening day of the fishing season by a party of three men. The largest fish weighed 11-3/4 pounds, and the three others weighed 2 pounds each.

Cutthroat trout, whitefish, and grayling are the only game fishes native to the area; however, all of the reservoirs and lakes included in the study and most of the larger streams have been stocked in the past with various game species now present. Introductions of trout apparently were first made about 1895. It is believed that, before stocking, no trout were present above the natural falls on which Diversion Dam was built, although evidence of this is not entirely conclusive.

The regular fishing season opened on May 20, 1951, and closed on November 15, except at Pishkun Reservoir, which was opened to fishing from July 15 through the following February 29. Winter fishing was permitted in all of the North Fork Sun River below Diversion Dam and in Willow Creek Reservoir during the months of December, January, and February. Daily and possession limits were as follows: Trout and whitefish, 15 fish, not to exceed 10 pounds and one fish; grayling, 5 fish, no weight limit; pike, 15 fish, not to exceed 15 pounds and one fish; and bass, 15 pounds and one fish, no limit on number. Minimum size limits permitted the taking of not more than 5 trout or whitefish under 7 inches in length and no pike under 18 inches in length. There was no creel or size limit on yellow perch or suckers. During the winter season the creel limit on the river was 15 fish, of which not more than 3 could be trout.

METHODS

Creel-census activities started with the opening of the fishing season on May 20 and continued until September 30, a period of 133 days. A 4-day check was made during October in an attempt to provide a basis for estimating the amount of fishing during the period October 1 to November 15.

To facilitate the study, 18 check areas 2/ were designated. Characteristics of the body of water or limitations of access were the primary considerations in making the designations. Data recorded at each check area were kept separate, and estimates of total fishing pressure and yield were made independently for each.

Because of limited access, it was necessary for virtually all parties fishing above Diversion Dam, except those using the upper extremities of the two forks of the river, to pass through a checking station established near Diversion Dam. This station was operated continuously during daylight hours, except for two weekdays each week. An auxiliary checking station was maintained during much of the season at the head of Gibson Reservoir. Interviews for the South Fork, North Fork, North Fork-South Fork area, Gibson Reservoir, Middle River, Beaver Creek, and Diversion Reservoir check areas were made at one or the other of these checking stations. The "North Fork" and "South Fork" check areas were used to designate fishing on the respective streams (exclusive of a half-mile stretch of each immediately above their junction) which could be checked at either of the two checking stations. The "North Fork-South Fork" check area was used to designate fishing that occurred at or near the junction of the two forks (within one-half mile) where, because of overlapping use of the two streams, it was impossible to separate the data.

2/ See table 1 for listing of check areas.

Access roads leading to the upper portions of the South and North Forks of the North Fork terminate at the Bench Mark Ranger Station on the former and near the Ear Mountain Ranger Station on the latter. "Bench Mark" and "Teton" were used to designate fishing in the two forks by fishermen who passed through these two points. Through the cooperation of resort owners, packers, Forest Service personnel, and others, it was possible to maintain a record of such use by making weekly trips to these areas.

A 2-week (June 24 to July 7) intensive census of Wood Lake was made by means of a checking station.

Accounting for fishermen using the 22 miles of the main river below Diversion Dam presented a special problem, since there were several trails leading to the river from the main road and it was not feasible to use checking stations except for the extreme upper one-half mile. A census was made of the upper 6 miles (Lower River A) and lower 5 miles (Lower River B) of this reach of stream by means of periodic patrols; but the intervening 11-mile section (Lower River C) was checked only occasionally because of limited pressure and difficulty in traversing the rough road along the river. Fishermen using Pishkun Reservoir, Pishkun Canal, Tunnel Lake, and Split Rock Lakes were generally checked as they passed through checking stations at Pishkun Reservoir or below Diversion Dam, but periodic patrols also were made of these areas. Willow Creek Reservoir was censused by patrolling. Checks were made of the above areas on an alternate-week basis.

Information concerning the number of fishermen in the party, hours spent fishing, type of fishing, residence and sex of fishermen, the catch by species, and the cost of the fishing trip was recorded. Weights and lengths of a nonselective sample of fish in creels also were obtained. Estimates of the total weight of the catch were based on the average weights thus obtained. The data were recorded on punch cards, which facilitated fast and accurate compilation.

Creel-census data were collected on a party basis. All the fishermen in one boat or the occupants of one or more automobiles who fished together were treated as a party. By using this system, it was usually possible to secure the necessary information from one member of the party, thereby enabling the crews to accumulate considerably more data than would otherwise have been possible.

Creel data were compiled on a biweekly basis, and estimates of fishing and yield were based on the respective compilations. Judgment factors were used in arriving at estimates of fishing and yield for Lower River C.

Trip expenditures, which included the expenditure per day for food, lodging, bait, rentals, and miscellaneous items such as refreshments, film, ice, and similar items, were recorded on a party basis for each party contacted. Average trip expenditures and round-trip mileage per person per day were computed for four major units of the study: (1) above Gibson Reservoir, (2) Gibson Reservoir, (3) below Gibson Reservoir, and (4) Wood Lake. A rate of 7 cents per mile was used to determine transportation costs.

The fishing activity of the individual fisherman is expressed in terms of "fisherman-days" and "fisherman-hours (pole-hours)." As the term implies, a fisherman-day represents a day of fishing by an individual, irrespective of the number of hours involved. The term "fisherman-hours" represents the number of hours fished by a fisherman.

In a few instances complete data were not obtained on all aspects of the study; those interview records were omitted in calculating the particular aspects for which data were incomplete. Accordingly, the number of individuals in the various samples listed in tables is not always the same.

RESULTS OF CREEL CENSUS

Based on recorded data shown in tables 1, 2, 3, and 4, it is estimated that the fishing and yield in 1951 3/ of the North Fork Sun River (from its headwaters to its junction with the Willow Creek outlet canal), including that from Gibson and Diversion Reservoirs, was 7,201 fisherman-days (33,455 fisherman-hours), and 14,755 fish weighing 6,728 pounds (table 5). Estimates of fishing and yield, reduced to a surface-acre or mile-of-stream basis are shown in table 6.

Table 5 indicates that there was slightly more fishing pressure and yield on the approximate 80 miles of the North Fork Sun River than on the 1,460 acres of water in Gibson and Diversion Reservoirs. Table 5 also shows considerable variation in the fishing pressure between the various units of the river. It is believed that this situation can be attributed largely to accessibility.

The upper section of the river (above Gibson Reservoir) was accessible only by trail or by boat. Relatively few people fish in this extensive, scenic, wilderness area, although there were at least seven dude ranchers who made a business of packing people into this area and one outfit (K-L Ranch) provided lodging facilities within easy walking distance of the area.

3/ Estimates are for the period May 20 to September 30, 1951, only; however, on the basis of only two parties observed in the 4-day period, October 26-29, and interrogation of local residents and State Fish and Game Department employees at the game checking station, it is believed that fishing in the area under study was small between October 1 and November 15, the end of the regular open season. Although weather conditions were extremely bad throughout the 4-day check period and thus could account for the limited fishing at that time, the weather in the study area ordinarily can be expected to be on the extreme side after the end of September. Furthermore, the North Fork Sun River area is one of the major elk hunting areas in Montana, and most local people devote much of their spare time during the fall and early winter to hunting. In the past, winter fishing has been rather extensive, but no attempt was made to determine its extent during the winter of either 1950-51 or 1951-52.

TABLE 1.--Number of parties, number of fishermen contacted, and average number of fishermen per party, North Fork Sun River and associated fisheries, Montana, 1951.

			Check Area	Parties contacted	Fishermen contacted	Fishermen per party
			Wood Lake	50	139	2.78
	Associated Fisheries		Pishkun Canal	34	64	1.88
			Pishkun Reservoir	230	495	2.15
			Willow Creek Reservoir	35	65	1.86
			Tunnel Lake	70	191	2.73
			Split Rock Lakes	71	192	2.70
			Total	440	1,007	2.29
North Fork Sun River	Reservoirs		Gibson Reservoir	163	508	3.12
			Diversion Reservoir	556	1,357	2.44
			Subtotal	719	1,865	2.59
	Stream Section	Upper	South Fork 1/	28	60	2.14
			Bench Mark 1/	6	24	4.00
			North Fork 2/	22	47	2.14
			Teton 2/	17	69	4.06
			North Fork-South Fork	36	120	3.33
			Subtotal	109	320	2.94
		Middle	Middle River	543	1,189	2.19
			Beaver Creek	38	78	2.05
			Subtotal	581	1,267	2.18
		Lower	Lower River A	251	571	2.27
			Lower River B	27	54	2.00
			Lower River C	32	76	2.38
			Subtotal	310	701	2.26
			Total	1,000	2,288	2.29
			Total	1,719	4,153	2.42
			Grand Total	2,209	5,299	2.40

1/ Both check areas on the South Fork of the North Fork Sun River.

2/ Both check areas on the North Fork of the North Fork Sun River.

TABLE 2.--Recorded pole-hours, recorded fish, and rate of catch, North Fork Sun River and associated fisheries, Montana, 1951.

		Check Area	Recorded pole-hours	Recorded fish	Average rate of catch	
					Numbers of fish per hour	Pounds of fish per hour
		Wood Lake	704	185	0.26	0.11
Associated Fisheries		Pishkun Canal	182	102	0.56	0.19
		Pishkun Reservoir	1,655	119	0.07	0.10
		Willow Creek Reservoir	249	44	0.18	0.25
		Tunnel Lake	1,035	149	0.14	0.12
		Split Rock Lakes	1,201	77	0.06	0.23
		Total	4,322	491	0.11	0.16
North Fork Sun River	Reservoirs	Gibson Reservoir	2,844	1,072	0.38	0.29
		Diversion Reservoir	6,529	2,161	0.33	0.14
		Subtotal	9,373	3,233	0.34	0.19
	Stream Section, Upper	South Fork 1/	265	117	0.44	0.32
		Bench Mark 1/	119	47	0.39	0.28
		North Fork 2/	195	108	0.55	0.32
		Teton 2/	272	102	0.38	0.27
		North Fork-South Fork	704	112	0.16	0.14
		Subtotal	1,555	486	0.31	0.23
	Stream Section, Middle	Middle River	4,695	2,146	0.46	0.13
		Beaver Creek	294	222	0.76	0.18
		Subtotal	4,989	2,368	0.47	0.13
	Stream Section, Lower	Lower River A	2,408	1,759	0.73	0.32
		Lower River B	206	99	0.48	0.20
		Lower River C	232	180	0.78	0.34
		Subtotal	2,846	2,038	0.72	0.30
		Total	9,390	4,892	0.52	0.20
		Total	18,763	8,125	0.43	0.19
		Grand Total	23,789	8,801	0.37	0.18

1/ Both check areas on the South Fork of the North Fork Sun River.

2/ Both check areas on the North Fork of the North Fork Sun River.

TABLE 3. Number and percent of recorded fish by species, North Fork Sun River and associated fisheries, Montana, 1951.

Check Area		Rainbow Trout		Brown Trout		Cutthroat Trout		Brook Trout		Grayling		Whitefish		Pike		Yellow Perch		Largemouth Bass		Suckers	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Wood Lake		59	32	0		63	34	63	34	0		0		0		0		0		0	
Associated Fisheries	Pishkun Canal	64	63	0		19	19	17	17	1/		1	1	0		0		0		0	
	Pishkun Reservoir	82	69	0		2	2	0		24	20	0		0		6	5	0		5	4
	Willow Creek Reservoir	15	34	0		2	5	5	11	0		0		0		0		0		22	50
	Tunnel Lake	134	90	11	7	1	1	1	1	0		0		0		0		0		2	1
	Split Rock Lakes	0		0		0		0		0		0		74	96	2	3	1	1	0	
	Total	295	60	11	2	24	5	23	5	24	5	1	2/	74	15	8	2	1	2/	29	6
North Fork Sun River Stream Sections — Reservoirs	Gibson Reservoir	998	93	0		56	5	15	1	1/		0		0		0		0		2	2/
	Diversion Reservoir	1,661	77	0		62	3	408	19	0		28	1	0		0		0		1	2/
	Subtotal	2,659	82	0		118	4	423	13	0		28	1	0		0		0		3	2/
Upper	South Fork	109	93	0		5	4	3	3	0		0		0		0		0		0	
	Bench	46	98	0		0		1	2	0		0		0		0		0		0	
	North Fork	77	71	0		2	2	29	27	0		0		0		0		0		0	
	Teton	102	100	0		0		0		0		0		0		0		0		0	
	North Fork-South Fork	100	90	0		6	5	5	4	0		0		0		0		0		1	1
	Subtotal	434	89	0		13	3	38	8	0		0		0		0		0		1	2/
Middle	Middle River	1,652	77	0		120	6	358	16	1/		15	1	0		0		0		0	
	Beaver Creek	101	46	0		12	5	109	49	0		0		0		0		0		0	
	Subtotal	1,753	73	0		132	6	467	20	0		15	1	0		0		0		0	
Lower	Lower River A	1,009	57	0		26	1	49	3	6	2/	669	38	0		0		0		0	
	Lower River B	58	59	0		1	1	4	4	1	1	24	24	0		0		0		11	11
	Lower River C	99	55	0		2	1	3	1	1	1	75	42	0		0		0		0	
	Subtotal	1,166	57	0		29	1	56	3	8	2/	768	38	0		0		0		11	1
Total		3,353	69	0		174	4	561	11	8	2/	783	16	0		0		0		12	1
Total		6,012	74	0		292	4	984	12	8	2/	811	10	0		0		0		15	2/

1/ See footnote 1, page 7

2/ Less than 1 percent

TABLE 4.--Average weight of fish in a nonselective sample from fisherman's creels, North Fork Sun River and associated fisheries, Montana, 1951.

	Check Area	Rainbow Trout		Brown Trout		Cutthroat Trout		Brook Trout		Grayling		Whitefish		Pike		Yellow Perch		Largemouth Bass		Suckers	
		No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
	Wood Lake	6	0.58			17	0.44	8	0.20												
Associated Fisheries	Pishkun Canal	8	0.38			5	0.25	1/	0.25			1/	0.50							1/	1.13
	Pishkun Reservoir	37	1.64			1/	1.00			8	1.08					3	0.19			2	1.13
	Willow Creek Reservoir	10	2.17			1/	1.00	1/	0.50											1/	1.13
	Tunnel Lake	14	0.69	1	2.60	1/	0.69	1	0.95												
	Split Rock Lakes													26	3.77	1/	0.19	1	2.65		
North Fork Sun River	Reservoirs: Gibson Reservoir	70	0.75			10	2/ 0.83	3	0.36											1/	1.00
	Reservoirs: Diversion Reservoir	192	0.46			6	0.32	38	0.37			1/	0.50							1/	0.48
	Streams: North & South Forks	1/	0.73			1/	0.72	1/	0.19												
	Streams: North Fork-South Fork	16	0.96				2/ 0.83	1/	0.19											1/	1.00
	Streams: Middle River	105	0.30			12	0.24	42	0.19			1	0.38								
	Streams: Beaver Creek	1/	0.30			1/	0.24	1/	0.19												
	Streams: Lower River	96	0.36			1/	0.24	1/	0.19	3	0.64	47	0.53							8	0.28

1/ Average weight estimated, either because sample was inadequate or no fish were weighed. Estimates based on the average weight as determined for same species from closely associated waters or observations of dressed fish.

2/ Sample from North Fork-South Fork and Gibson Reservoir combined because of inadequacy of sample from North Fork-South Fork.

TABLE 5.--Estimated fishing pressure and yield, North Fork Sun River and associated fisheries, Montana, 1951.[1/]

		Area	Fishing pressure		Yield	
			Fisherman-days	Fisherman-hours	Number of fish	Pounds of fish
		Wood Lake [2/]	385	1,965	494	199
Associated Fisheries		Pishkun Canal	179	509	260	87
		Pishkun Reservoir	1,575	6,295	534	759
		Willow Creek Reservoir	202	746	191	270
		Tunnel Lake	504	2,561	359	299
		Split Rock Lakes	516	3,518	201	740
		Total	2,976	13,629	1,546	2,155
North Fork Sun River	Reservoirs	Gibson Reservoir	895	5,001	1,903	1,415
		Diversion Reservoir	2,328	11,992	4,321	1,878
		Subtotal	3,223	16,993	6,224	3,313
	Stream	Upper Section	668	3,222	1,129	832
		Middle Section	2,020	8,238	3,807	1,073
		Lower Section	1,290	5,002	3,595	1,510
		Subtotal	3,978	16,462	8,531	3,415
		Total	7,201	33,455	14,755	6,728

1/ See footnote 3, page 11.

2/ Estimates are for 2-week period, June 24 to July 7, only.

TABLE 6.--Estimated fishing pressure and yield, per surface acre of reservoirs and lakes, or per mile of streams, North Fork Sun River and associated fisheries, Montana, 1951.

	Area	Surface acres of reservoirs (A) or miles of stream (M)	Per surface area of reservoir or mile of stream		
			Fishing pressure	Yield	
			Fisherman-days	Numbers of fish	Pounds of fish
Reservoirs or lakes	Wood Lake 1/	20 A	19.3	24.7	10.0
	Pishkun Reservoir	1,550 A	1.0	0.3	0.5
	Willow Creek Reservoir	1,400 A	0.1	0.1	0.2
	Tunnel Lake	30 A	16.8	12.0	10.0
	Split Rock Lakes	120 A 2/	4.3	1.7	6.2
	Gibson Reservoir	1,360 A	0.7	1.4	1.0
	Diversion Reservoir	100 A	23.3	43.2	19.0
Streams	Upper Section NFSR	50 M 3/	13.3	22.6	16.6
	Middle Section NFSR	8 M 4/	252.5	475.9	134.1
	Lower Section NFSR	22 M	58.6	163.4	68.6
	Pishkun Canal	12 M	14.9	21.7	7.3

1/ Estimates are for 2-week period, June 24 to July 7, only.

2/ Estimated acreage of waters fished.

3/ Tributaries of the North and South Forks of the North Fork Sun River were fished, and fishing in these tributaries is included in information and calculations for the "North Fork" and "South Fork" units. It was not possible however, to determine exactly the miles of the various tributaries which were fished; thus these were excluded in determining mileage. The 50 miles include approximately 25 miles each for the North and South Forks.

4/ Beaver Creek included.

The middle section, which included 3 miles of the main river and Beaver Creek, was the most heavily fished portion of the river, probably because it was readily accessible by a good forest road along its whole length.

Fishing in the lower section of the river was relatively light in spite of a fairly high average rate of catch (table 2). Again, this probably was because of poor access; generally speaking the area was accessible at only isolated points over rather poor ranch roads. The importance of accessibility is borne out when it is realized that about 54 percent (695) of the estimated 1,290 fisherman-days expended on this section were spent in the first 3 miles (fig. 2), immediately below Diversion Dam where the approach road from Augusta came within a few hundred yards of the river.

Gibson Reservoir, which was 13 times larger than Diversion Reservoir, sustained a fishing pressure of only about one-third that at the latter impoundment. The greater use of Diversion Reservoir probably can be attributed principally to better access, although other factors, such as the presence of established picnic sites and greater safety, may have contributed to it. A good road led to and along one side of Diversion Reservoir, while Gibson Reservoir could be reached by car at one point only, and then only over an extremely rough and rocky road. Access to much of Gibson Reservoir was only by boat, on foot, or on horseback.

Except for minor variations due to differences in the rate of catch, the composition of the catch, and the average weight of the various species taken, differences in yield from unit to unit seemed to be closely tied to access.

Essentially all of the fish taken from the North Fork Sun River and the two onstream reservoirs were game fish and included rainbow, cutthroat, hybrid (rainbow x cutthroat) 4/ and brook trout, grayling, and whitefish. Over 90 percent of the catch consisted of trout. Details of the composition of the catch are shown in table 3.

The average weights of the various species of fish caught are shown in table 4. Admittedly, some of the samples are too small to be statistically reliable; nevertheless, it is believed that the samples were

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4/ Specimens considered by crew members to be hybrids or integrades between rainbow and cutthroat trout were recorded, but for the purpose of this report, all such specimens have been considered as rainbows and consequently are not shown in table 3 (composition of catch) or table 4 (average weights).

representative 5/, and that rainbow and cutthroat trout taken in Gibson Reservoir and the stream above were about twice as large as those taken below Gibson Reservoir.

The average rate of catch for the North Fork Sun River fishery as a whole was 0.43 fish per hour (table 2). The average rate for the two reservoirs was 0.34 fish per hour, considerably less than the 0.52 fish per hour for the stream. Both the highest and lowest rates of catch were recorded on sections of the stream (0.78 fish per hour on one portion of the Lower River and 0.16 fish per hour at the junction of the two forks of the North Fork Sun River). The 0.34 fish per hour for the two reservoirs was more or less intermediate between the two extremes for the stream.

The average rate of catch in terms of pounds of fish per hour varied from 0.13 pound per hour (Middle River) to 0.34 pound per hour (Lower River C); that for the area as a whole was 0.19 pound per hour. The average for the two reservoirs (0.19) and that for the stream (0.20) were essentially the same. Variations in rate of catch for the several check areas are shown in table 2.

Estimated fishermen use and yield in 1951 6/ of the associated fisheries, exclusive of that of Wood Lake 7/, was about 2,976 fishermen-days (13,629 fisherman-hours) and 1,546 fish weighing 2,155 pounds (tables 5 and 6). This represents only about 29 percent of the use, about 9 percent of the yield in numbers, and about 24 percent of the yield in pounds of fish of that of the entire study area, in spite of the fact that there are about 1,000 8/ more acres of waters in the associated fisheries than in the

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5/ Larger samples could not be secured because fishermen generally cleaned their fish before leaving fishing waters, but a sufficient number of cleaned fish were examined to justify the conclusion reached. Data obtained on 30 fish taken from the upper section in 1951, but not recorded during the course of the census, tends to substantiate the stated contention. The 12 rainbow, 3 cutthroat, 6 hybrid, and 10 brook trout in this sample averaged 1.52, 0.95, 1.43, and 0.33 pounds, respectively.

6/ See footnote 3, page 11.

7/ Wood Lake is unaffected by water development on the North Fork Sun River and will be discussed separately.

8/ Acreage in Pishkun Reservoir (1,550 acres), Willow Creek Reservoir (1,400 acres), Tunnel Lake (30 acres), and Split Rock Lakes (about 100 acres), excluding that in Pishkun Canal, equals about 3,100 acres, whereas Gibson Reservoir (1,360 acres), Diversion Reservoir (100 acres), and an estimated 700 acres in the river equals about 2,100 acres.

North Fork Sun River fishery. Again, the relatively small amount of fishing probably can be largely attributed to poor access. None of the waters in the associated fisheries were adjacent to a good road. The much lower average rate of catch for the associated fisheries (0.11 fish per hour and 0.16 pound per hour) as compared with that on the North Fork Sun River (0.48 fish per hour and 0.20 pound per hour) undoubtedly contributed to the fact that there was less fishing on the former areas. The fact that Pishkun Reservoir was not open to fishing until July 15 also may have been a contributing factor.

Slightly more than half of the fishing of the associated fisheries was on Pishkun Reservoir, but only about a third of the yield in numbers and pounds of fish came from this reservoir. Although access to the associated fisheries was not particularly good in general, Pishkun Reservoir was accessible to people of Choteau and towns to the north and east over a fair road direct from Choteau. The reservoir had the reputation of producing an occasional 4- or 5-pound rainbow trout. Since more than 72 percent of the parties fishing in Pishkun came from Choteau and other towns north and east of there, access again seems to be a major factor contributing to the amount of fishing.

As in the North Fork Sun River, essentially all the fish taken in the associated fisheries were game fish. Trout (rainbow, brown, cutthroat, and brook) and grayling constituted 77 percent of the catch, while pike, yellow perch, and largemouth black bass constituted 17 percent of the catch. About 6 percent of the catch was suckers. Pike and bass were taken from Split Rock Lakes only. Perch were taken from both Pishkun Reservoir and Split Rock Lakes. Details of the composition of the catch are shown in table 3.

The average rate of catch on all units of the associated fishery, except that of Pishkun Canal, was considerably smaller than that on the North Fork Sun River (table 2), although the average weight of most species of fish taken was greater (table 4). The average rate of catch of 0.56 fish per hour (0.19 pound per hour) determined for Pishkun Canal is quite comparable to that of the North Fork Sun River, probably because most of the recorded fishing in the canal was near the intake at Diversion Reservoir.

Split Rock Lakes, which were essentially pike waters, were comparatively productive in terms of pounds of fish per hour (0.23), but in terms of fish per hour they had the lowest rate of catch of any of the waters in the study area (0.06). The average weight of pike, which constituted 96 percent of the catch, was 3.77 pounds. These lakes were especially attractive to those individuals who like to fish leisurely with live minnows.

Wood Lake, near the head of Wood Creek, a tributary of the South Fork of the North Fork, probably should have been given equal consideration with the South Fork in this study. Because of its remoteness from the main census area, personnel limitations, and other difficulties, it was censused for a 2-week period only, and it was not possible to estimate pressure and yield for the same period as the other fisheries. During the 2-week census (June 22 to July 7, probably the period of heaviest fishing) 50 parties were contacted. The contacted fishermen (139) caught 185 fish, all of which were trout. The catch was comprised of approximately equal numbers of rainbow trout, cutthroat trout, and brook trout (table 3). The average rate of catch was 0.26 fish per hour (0.11 pound per hour). The average weight of trout taken was about 0.44 pound. It is estimated that a total of 385 fisherman-days (1,965 fisherman-hours) was expended, and 494 trout, weighing 199 pounds, were taken at Wood Lake (tables 5 and 6) during the period June 22 to July 7.

Miscellaneous Information

About 98 percent of the fishermen contacted during the course of the study were residents of Montana (table 7); of these, 72 percent came from Great Falls. Nonresident fishermen came from 21 States. Approximately 96 percent of the fishermen in the contacted parties came from an area within a 100-mile radius (which included Great Falls), 32 percent came from within a 50-mile radius, and 3 percent came from within a 25-mile radius (table 8). The small percentage of fishermen from within the 25-mile radius can be directly attributed to the limited population in that zone. That 64 (77 percent) of the 83 fishermen who came from a distance of over 300 miles were nonresidents, indicates the attractiveness of this wilderness area to nonresidents.

Men comprised 77 percent of the total number of anglers in the contacted parties, women 14 percent, and children 9 percent.

The largest fish recorded during the study was a 11.7-pound pike. The largest trouts were a rainbow weighing 2.9 pounds and two browns weighing 3.6 pounds each.

Boats were used by about 43 percent of the fishing parties contacted at Gibson Reservoir, 26 percent at Diversion Reservoir, and 11 percent at Split Rock Lakes. Boats were prohibited on the other reservoirs in the study area; only three boats were observed on the streams during the census.

Until the first part of July, bait fishing was the most common method of fishing; after that time fly fishing became increasingly popular. Grasshoppers were the favorite bait at Pishkun Reservoir, and minnows were favored at Split Rock Lakes.

On the average, each fisherman-day was 4.5 hours long. Extremes in the length of the average fisherman-day for the various areas were 2.8 hours on Pishkun Canal and 6.3 hours on Split Rock Lakes. The average was

TABLE 7.--Number and percent of resident and nonresident fishermen, North Fork Sun River and associated fisheries, Montana, 1951.

Residency	Below Gibson Reservoir		Gibson Reservoir		Above Gibson Reservoir 1/		Total	
	No.	%	No.	%	No.	%	No.	%
Residents	2,310	99	489	96	389	86	3,118	98
Nonresidents	32	1	19	4	64	14	115	2
Total	2,342	100	508	100	453	100	3,303	100

1/ Includes Wood Lake.

TABLE 8.--Number and percent of fishermen from various radii (in miles), North Fork Sun River and associated fisheries, Montana, 1951.

Radius of influence	Below Gibson Reservoir		Gibson Reservoir		Above Gibson Reservoir 1/		Total	
	No.	%	No.	%	No.	%	No.	%
0-25 mile radius	122	5	23	5	19	4	164	5
25-50 mile radius	1,233	53	180	35	80	18	1,493	45
50-100 mile radius	892	38	258	51	261	58	1,411	43
100-200 mile radius	30	1	2	2/	6	1	38	1
200-300 mile radius	22	1	18	4	4	1	44	1
Over 300 miles	43	2	27	5	83	18	153	5
Total	2,342	100	508	100	453	100	3,303	100

1/ Includes Wood Lake.

2/ Less than 1 percent.

4.7 hours for the stream above Gibson Reservoir, 3.9 hours for the middle section of the river, and 4.1 for the lower section. Fisherman-hours per day on the reservoirs averaged as follows: Gibson Reservoir, 5.6 hours; Diversion Reservoir, 4.8 hours; Pishkun Reservoir, 3.3 hours; Willow Creek Reservoir, 3.8 hours; Tunnel Lake, 5.4 hours; Split Rock Lakes, 6.3 hours; and Wood Lake, 5.1 hours.

Most of the fishermen made only 1-day trips to the area, but a sufficient number made extended trips of such duration (2 to 57 days) that the average was 1.9 days for the area below Gibson Reservoir, 2.0 for Gibson Reservoir, 3.5 for the area above Gibson Reservoir, and 1.4 for Wood Lake.

RESULTS OF FISHERMAN-EXPENDITURE STUDY

On the assumption that expenditures made by fishermen using a fishery are an indication of its monetary value, data pertaining to this aspect of the fisheries were obtained during the course of the creel census. Because of difficulties inherent in obtaining certain types of expenditure information (Fish and Wildlife Service, 1951c), the present survey was restricted to items relating to trip and transportation expenses; to complete the analysis, investment and annual expenditure figures obtained in another study in Montana are included.

Because fishermen's expenditures were considerably higher in the more remote locations of the study area, expenditure data were compiled separately for the waters below Gibson Reservoir, for Gibson Reservoir, and for waters above Gibson Reservoir. Fishing and yield data were secured for only a 2-week period on Wood Lake, so expenditure data for this unit were compiled separately. In the following analysis of fishermen's expenditures, data are presented for each of the locations, as well as for the study area as a whole.

The average round-trip mileage and transportation expenditure (at 7 cents per mile) for 1 day of fishing for each fisherman was computed as follows: below Gibson Reservoir, 38.7 miles, $2.71; Gibson Reservoir, 31.1 miles, $2.18; above Gibson Reservoir, 41.0 miles, $2.87; and Wood Lake, 45.9 miles, $3.21. The average round-trip mileage and transportation expenditure for the area as a whole was 38.5 miles and $2.70.

Trip expenditures made up of items listed in table 9 varied from $0 to $18.00 per person per day, and averaged $0.70 in the area below Gibson Reservoir, $1.89 for Gibson Reservoir, $5.33 in the area above Gibson Reservoir, and $0.43 for Wood Lake. The average for all areas was $1.07. Trip expenditures were higher in the more remote areas (except Wood Lake) because of boat rentals, horse rentals, and guide service, and the greater cost of lodging, food, and miscellaneous items. The considerably lower expenditure for Wood Lake fishermen can be accounted for by the fact that most of the individuals spent only 1 day per fishing trip, thus they had no expenditures for many of the items listed in table 9. Considering the study area as a whole, approximately 44 percent of the fishermen did not make any purchases of supplies or services.

TABLE 9.--Trip expenditures, North Fork Sun River and associated fisheries, Montana, 1951.

Area	Number fishermen in sample	Trip expenditures								Average expenditure per person per day
		Food	Lodging	Bait	Fees	Miscellaneous	Boat rental	Other rental	Total	
Below Gibson Dam	4,203	$ 953.03	$528.90	$60.04	$ 21.45	$1,384.19	$ 7.25	$ 3.65	$2,958.51	$0.70
Gibson Reservoir	460	193.16	51.50	11.30	85.60	413.22	63.80	50.50	869.08	1.89
Above Gibson Reservoir	298	184.00	32.00	1.25	1,059.50 1/	218.81	47.75	45.00	1,588.31	5.33
Wood Lake	139	11.12	15.25	0.38	33.40	0.00	0.00	0.00	60.15	0.43
Total	5,100	$1,341.31	$627.65	$72.97	$1,199.95	$2,016.22	$118.80	$99.15	$5,476.05	$1.07

1/ Mostly for outfitters or packers.

Although annual and investment expenditure data were not obtained during the study, information on these two expenditures is available from a study conducted in three Montana counties (Fish and Wildlife Service, 1951c). Data from the county survey are assumed to be applicable to this study, since the type of equipment used by the fishermen was similar to that used by the cold-water fishermen interviewed during county survey and the license fee was the same. The county survey revealed considerable variation in the per-person per-day expenditure for combined investment and annual items between cold-water fishermen in Valley and Roosevelt Counties ($2.97) and Yellowstone County ($3.65); but because of the better sample from Yellowstone County 9/, it is believed that the Yellowstone County fishermen's expenditure for cold-water fishing more closely approximates the expenditures of the fishermen with which this report is concerned. Accordingly, data from Yellowstone County, modified as indicated below, have been applied in completing the analysis of the North Fork Sun River and associated fisheries.

The Yellowstone County survey indicated that the average cold-water fisherman spent $3.65 per day for combined annual and investment items, but it was necessary to modify this value before it could be used for the present purpose. The data gathered in the county survey referred to the per-person per-day expenditure of the average license holder rather than the average fisherman in the field. Therefore, the data were weighted according to the number of times the fisherman went fishing, to obtain the expenditure for the average individual in the field. Modification of the Yellowstone County data was accomplished as follows: The average season expenditure for combined annual and investment items ($33.50) was divided by the average number of days (12.5) the fishermen spent cold-water fishing to determine the per-day expenditures of $2.68 (rounded to $2.50). Approximately three-fourths of the $2.68, or $2.20, was for investment items, and the remaining $0.48 was for annual expenditures; after rounding, these figures were $2.05 and $0.45, respectively.

Using the combined trip and transportation expenditures obtained during the creel census (below Gibson Reservoir, $3.41; Gibson Reservoir, $4.07; above Gibson Reservoir, $8.20; and Wood Lake, $3.64) with the combined annual and investment expenditures ($2.50) from the Yellowstone County survey, average total expenditures per person per day of about $5.91 for the area below Gibson Reservoir, $6.57 for Gibson Reservoir, $10.70 for the area above Gibson Reservoir, and $6.14 for Wood Lake were derived. The percentage distribution of the component parts of the total daily expenditure per person are shown for each fishery in Fig. 5.

9/ Eighty-two percent of the 187 license holders in Yellowstone County could be classified as cold-water fishermen, as against only 18 percent of the 170 license holders interviewed in Valley and Roosevelt Counties (Fish and Wildlife Service, 1951c).

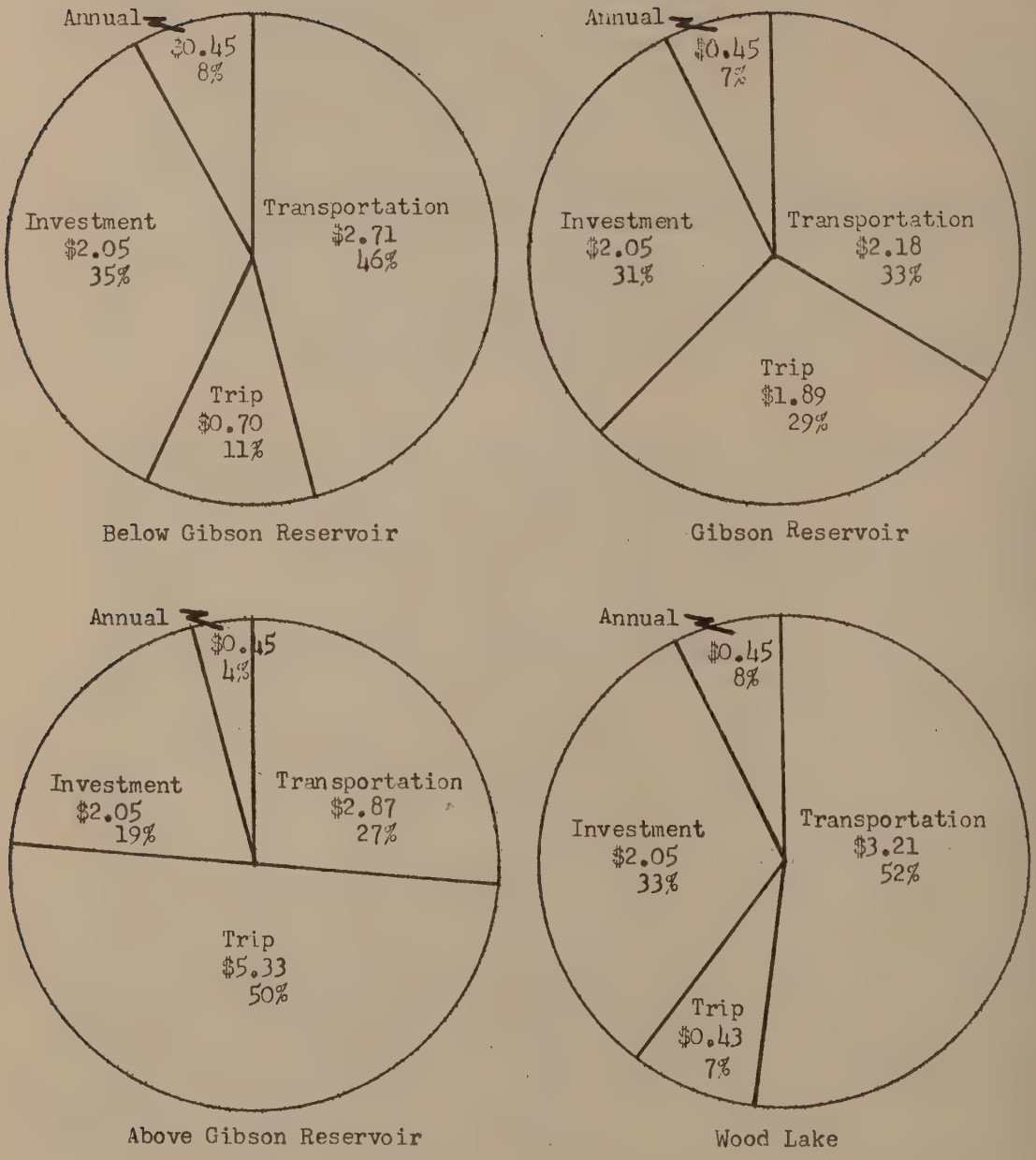

Fig. 5.--One-year creel census and fisherman-expenditure study, North Fork Sun River and Associated Fisheries, Montana, 1952.

TABLE 10.--Fisherman-expenditure data, North Fork Sun River and associated fisheries, Montana, 1951.

Item	Below Gibson Dam	Gibson Reservoir	Above Gibson Reservoir	Wood Lake
Estimated total number of fisherman-days	8,614	895	668	385
Average expenditure per person per day	$ 5.91	$ 6.57	$10.70	$ 6.14
Estimated total value of fishery	$50,909	$5,880	$7,148	1/$2,364
Estimated total yield in pounds of fish	6,636	1,415	832	199
Average cost per pound of fish	$ 7.67	$ 4.16	$ 8.59	$11.88

1/ For 2-week period, June 24 to July 7, only.

Application of the average daily expenditures per fisherman to the total estimated number of fisherman-days for each area results in the following estimated values: Below Gibson Reservoir, $50,909; Gibson Reservoir, $5,880; above Gibson Reservoir, $7,148; and Wood Lake, $2,364 (table 10). It was estimated that 6,636 pounds of fish were taken from waters below Gibson Reservoir, 1,415 pounds were taken from Gibson Reservoir, 832 pounds were taken above Gibson Reservoir, and 199 pounds were taken from Wood Lake; thus, the costs per pound of fish were about $7.67, $4.16, $8,59, and $11.88, respectively.

DISCUSSION

Comparisons of the various check areas of the North Fork Sun River study area on the basis of total fishing pressure and yield have already been made, and considerable variation has been shown (tables 5 and 6). Variations in the physical and biological nature of the bodies of water, and more particularly in accessibility, lessen the significance of any comparison on this basis.

Fishing success, as measured by the rate of catch, offers a somewhat better means for comparison in judging the relative merits of the various waters. While rates of catch also may be affected by many of the same factors that cause variation in the total number of fisherman-days and yield, these values afford the best common denominator for comparison from the point of view of the angler.

There was considerable variation between the several check areas of the study even on the basis of fishing success (table 2); but, in general, rate of catch in terms of fish per hour and pounds of fish per hour of effort was better on the streams than on the reservoirs. With the exception of the 1-mile North Fork-South Fork area where the rate of catch was 0.16 fish per (0.14 pounds per hour), the seasonal rates of catch for the streams in the area ranged from 0.38 to 0.78 fish per hour, while the rate of catch on the reservoirs varied from 0.06 to 0.38 fish per hour. With respect to pounds of fish per hour, fishing success on the streams varied from 0.13 to 0.34, as compared with 0.10 to 0.29 for the reservoirs.

A number of creel-census studies have been made of other streams and reservoirs throughout the country; and, although for a variety of reasons few of these other bodies of water are comparable to those in the North Fork Sun River study area, comparisons on the basis of rate of catch provide a general idea of the relative quality of the fishing in waters of the North Fork Sun River study area. A comparison of rates of catch for streams is shown in table 11 and for reservoirs in table 12.

The rates of catch for streams in the study area, when tabulated with respect to numbers of fish caught per hours, occur in the lower three quarters of the other studies listed and therefore can be considered as

TABLE 11.--Comparative hourly rates of catch in numbers and pounds of fish from trout streams.

Stream [1]	Location	Year	Number of fish per hour	Number of pounds per hour	Reference
Horton Creek	Arizona	1936	1.61	0.34	Tarzwell, 1938
Tonto Creek	do.	1937	1.43	0.24	Do.
Tonto Creek	do.	1936	1.39	0.29	Do.
Horton Creek	do.	1937	1.31	0.17	Do.
Upper Sec., W. Gallatin River	Montana	1949	1.07	0.42	Fish & Wildlife Ser., 1951a
E. Branch of Tahquamenon Reservoir	Michigan	1940	1.02	0.24	Shetter, 1944
Republican River	Colorado	1946	0.96	[2] 0.36	Hess & Klein, 1946
Taylor River	do.	do.	0.89	[2] 0.36	do.
Fishdam River	Michigan	1940	0.80	0.35	Shetter, 1944
BEAVER CREEK	Montana	1951	0.76	0.18	- - - -
Big Thompson River	Colorado	1946	0.75	[2] 0.18	Hess & Klein, 1946
Cache La Poudre	do.	do.	0.72	[2] 0.20	Do.
LOWER RIVER, NORTH FORK SUN RIVER	Montana	1951	0.72	0.30	- - - -
Hunt Creek	Michigan	1939	0.63	0.09	Shetter, 1944
Gunnison River	Colorado	1946	0.62	[2] 0.29	Hess & Klein, 1946
White River	Michigan	1939	0.60	0.10	Shetter, 1944
Middle Sec., W. Gallatin River	Montana	1949	0.57	0.36	Fish & Wildlife Ser., 1951 a
PISHKUN CANAL	do.	1951	0.56	0.19	- - - -
Rio Grande	Colorado	1946	0.53	[2] 0.22	Hess & Klein, 1946
Middle Sec., W. Gallatin River	Montana	1950	0.51	0.35	Fish & Wildlife Ser., 1951a
Arkansas River	Colorado	1946	0.50	[2] 0.30	Hess & Klein, 1946
Pine River	Michigan	1939	0.49	0.10	Shetter, 1944
Pigeon River	do.	do.	0.48	0.11	Do.
MIDDLE RIVER, NORTH FORK SUN RIVER	Montana	1951	0.46	0.13	- - - -
Hunt Creek	Michigan	1940	0.45	0.07	Shetter, 1944
Madison River, Bear Trap Canyon	Montana	1950	0.45	0.45	Fish & Wildlife Ser., 1953
NORTH FORK, NORTH FORK SUN RIVER	do.	1951	0.45	0.33	- - - -
SOUTH FORK, NORTH FORK SUN RIVER	do.	do.	0.43	0.33	- - - -
North Branch, AuSable River	Michigan	1939	0.41	0.10	Shetter, 1944
Madison River, Below Canyon	Montana	1950	0.37	0.42	Fish & Wildlife Ser., 1953

TABLE 11.--(Cont'd)

Stream[1/]	Location	Year	Number of fish per hour	Number of pounds per hour	Reference
Little Manistee River	Michigan	1939	0.37	0.11	Shetter, 1944
North Branch, AuSable River	do.	1940	0.33	0.09	Do.
Canada Creek	do.	1939	0.32	0.08	Do.
White River	do.	1940	0.22	0.07	Do.

1/ Streams in upper case letters are in the North Fork Sun River Study Area.

2/ Computed from average lengths on the assumption that fish from this area had the same length-weight relationship as fish taken from the West Gallatin and Madison Rivers in Montana in 1949-1950.

TABLE 12.--Comparison of hourly rates of catch in numbers of fish and pounds of fish from western cold-water lakes and reservoirs.

Lake or reservoir[1]	Location	Year	Surface Acres	Number of fish per hour	Pound of fish per hour	Reference
Fish Lake	Oregon	1937	90	4.18	1.39	Needham & Cliff, 1938
Island Lake	Colorado	1940	160	2.10	[2]/0.84	Lyall, 1941
Fish Lake	Utah	do.	2.500	2.00	--	Wright, 1943
Fish Lake	do.	1941	2,500	1.80	--	Do.
Fish Lake	do.	1942	2,500	1.50	--	Do.
Ward	Colorado	1940	75	1.40	0.35	Lyall, 1941
Mesa	do.	do.	30	1.30	[2]/0.43	Do.
South Mesa	do.	do.	12	1.00	[2]/0.33	Do.
Castle Lake	California	1943	47	0.98	[2]/0.33	Wales, 1946
Castle Lake	do.	1945	47	0.95	[2]/0.32	Do.
Crater Lake	Oregon	1940	13,440	0.85	1.06	Hasler & Farner, 1942
Castle Lake	California	1944	47	0.79	[2]/0.26	Wales, 1946
S. Twin Lake	Oregon	1945	130	0.78	[2]/0.80	Holloway, 1949
Lost	Colorado	1940	3	0.65	0.22	Lyall, 1941
June Lake	California	1942	310	0.62	--	Vestal, 1943
June Lake	do.	1939	310	0.60	--	Do.
June Lake	do.	1941	310	0.56	--	Do.
June Lake	do.	1940	310	0.55	--	Do.
Fish Lake	Utah	1947	2,500	0.54	--	Anonymous, 1948
Deerfield Reservoir	South Dakota	1950	435	0.48	[2]/0.20	Fish & Wildlife Service, 1951b
S. Twin Lake	Oregon	1946	130	0.46	[2]/0.30	Holloway, 1949
Vallecito Reservoir	Colorado	1945	2,720	0.46	[2]/0.23	Hess & Klein, 1946
Big Lake	Arizona	1949	470	0.45	0.23	Borges
Upper Lake Mary	do.	do.	400	0.45	0.31	Do.
Castle Lake	California	1942	47	0.45	[2]/0.15	Wales, 1946
Deerfield Reservoir	South Dakota	1949	435	0.42	[2]/0.25	Fish & Wildlife Service, 1951b
Alexander	Colorado	1940	33	0.42	[2]/0.21	Lyall, 1941

TABLE 12.--(Cont'd)

Lake or reservoir[1/]	Location	Year	Surface	Number of fish per hour	Pounds of fish per hour	Reference
Paulina Lake	Oregon	1947	1,300	0.40	[2/]0.25	Holloway, 1949
Crater Lake	do.	1937	13,440	0.38	[2/]0.57	Hasler and Farner, 1942
GIBSON RESERVOIR	Montana	1951	1,360	0.38	0.29	- - - -
Castle Lake	California	1941	47	0.38	[2/]0.13	Wales, 1946
DIVERSION RESERVOIR	Montana	1951	100	0.33	0.14	- - - -
S. Twin Lake	Oregon	1947	130	0.33	[2/]0.27	Holloway, 1949
Vallecito Reservoir	Colorado	1946	2,720	0.32	[2/]0.16	Hess & Klein, 1946
Madison Reservoir	Montana	1950	3,800	0.32	0.39	Fish & Wildlife Service, 1953
Green Mt. Reservoir	Colorado	1945	2,100	0.30	[2/]0.30	Hess & Klein, 1946
Crater Lake	Oregon	1939	13,440	0.28	[2/]0.25	Hasler & Farner, 1942
WOOD LAKE	Montana	1951	20	0.26	0.11	- - - -
Green Mt. Reservoir	Colorado	1946	2,100	0.25	[2/]0.19	Hess & Klein, 1946
Groundhog Reservoir	do.	do.	424	0.24	0.24	Do.
Crater Lake	Oregon	1938	13,440	0.23	[2/]0.25	Hasler & Farner, 1942
East Lake	do.	1946	970	0.21	[2/]0.25	Holloway, 1949
East Lake	do.	1947	970	0.20	[2/]0.35	Do.
Paulina Lake	do.	1946	1,300	0.19	[2/]0.21	Do.
WILLOW CREEK RESERVOIR	Montana	1951	1,400	0.18	0.25	- - - -
Lower Mary Lake	Arizona	1949	400	0.17	0.20	Borges
Strawberry Reservoir	Utah	1948	8,200	0.15	--	Anonymous, 1949
TUNNEL LAKE	Montana	1951	30	0.14	0.12	- - - -
Alcova Reservoir	Wyoming	do.	2,500	0.09	0.11	Fish & Wildlife Service, 1952d
PISHKUN RESERVOIR	Montana	do.	1,500	0.07	0.12	- - - -
SPLIT ROCK LAKES	do.	do.	120	0.06	0.23	- - - -
Pathfinder Reservoir	Wyoming	do.	22,600	0.05	0.14	Fish & Wildlife Service, 1952d

1/ Reservoirs or lakes in upper case letters are in the North Fork Sun River Study Area.

2/ Computed. When only the average length was indicated, the assumption was made that fish from this area had the same length-weight relationship as fish taken from the West Gallatin and Madison Rivers in 1949 and 1950.

slightly below average (table 11). In general, the rates of catch in pounds of fish per hour compare somewhat more favorably, although even in this respect fishing in the study area was only about average (middle third of studies listed).

When comparing rates of catch on lakes and reservoirs in the study area with those of other lakes and reservoirs (table 12), the reservoirs in the study area fall within the lower two-thirds of other reservoirs listed, both in numbers and in pounds of fish per hour; thus, in general, they can be considered slightly below average.

Comparisons of fishing pressure and yield of the North Fork Sun River with a variety of other trout streams in Montana would be desirable. Unfortunately, the only streams on which comparable studies have been made are the West Gallatin and Madison Rivers, exceptionally productive waters which are readily accessible to fishermen. Fishing pressure and yield determined for a 28-mile stretch of the West Gallatin in 1950 was 460 fisherman-days and 580 fish or 400 pounds of fish per mile (Fish and Wildlife Service, 1951a); that for 98 miles of the Madison River determined over the period 1950 through 1952 was 231 fisherman-days and 535 fish or 494 pounds of fish per mile (Fish and Wildlife Service, 1953).

Considering the entire 80 miles of stream in the North Fork Sun River study area, pressure and yield per mile was 50 fisherman-days and 107 fish or 43 pounds of fish. Although these values are low compared with those of the foregoing streams, greater potentialities are suggested for the North Fork Sun River when comparisons are confined to the 8-mile middle section of the stream. In this section, where access is comparable to that of the West Gallatin and Madison Rivers, the pressure and yield per mile was 253 fisherman-days and 476 fish weighing 134 pounds (table 6). Except for the smaller yield in pounds per mile, this 8-mile, readily accessible section of the study area compared favorably with the West Gallatin and Madison. Were other portions of the North Fork Sun River equally accessible, pressure and yield of the river as a whole probably would be considerably greater.

Although fishing in some sections of the North Fork Sun River was light, probably because of poor access, the existence of such isolated areas is important to a certain segment of the population, and there is an apparent need for preservation of some areas in a more or less primitive state. This is illustrated by the use made of the approximate 50 miles of wilderness stream above Gibson Reservoir (17 percent of total pressure on the North Fork Sun River). This area was most attractive to nonlocal people, that is, those from the prairies to the east in Montana and from the eastern States. Approximately 55 percent of the nonresidents (from 21 States, 20 of which were east of Montana) who were contacted during the study used the fishery above Gibson. About 86 percent of the fishing above Gibson was by residents; however, excluding those individuals who came from a radius of over 300 miles and were mostly nonresidents, about

TABLE 13.--Comparison of the average expenditure per person per day, per pound of fish, and per surface acre or mile of stream for the North Fork Sun River and associated fisheries with other fisheries in the Missouri Basin.

Fishery	Average expenditure				Reference
	Per person per day	Per pound	Per surface area	Per mile	
Ocean Lake, Wyoming, 1947-1949	$ 9.22	$ 1.28	$ 18.66		Fish & Wild.Ser., 1950a
Lake Maloney, Nebraska, 1949-1950	2.42	1.09	25.96		Fish & Wild.Ser., 1950b
Republican River, Nebraska & Kansas, 1951	1.80	2.50		$ 733.00	Fish & Wild.Ser., 1952a
Fort Peck Reservoir, Montana, 1948-1950	2.80	1.60	3.60		Fish & Wild.Ser., 1952c
Pathfinder Reservoir, Wyoming, 1951 1/	7.22	3.95(8.27)	2.51		Fish & Wild.Ser., 1952d
Alcova Reservoir, Wyoming, 1951 1/	5.79	5.39(10.76)	11.00		Do.
Fremont Canyon, Wyoming, 1951 1/	6.49	4.55(9.22)		2,190.00	Do.
NORTH FORK SUN RIVER AND ASSOCIATED FISHERIES, MONTANA, 1951					
BELOW GIBSON RESERVOIR					
MIDDLE SECTION OF RIVER	5.91	11.13		1,492.28	
LOWER SECTION OF RIVER	5.91	5.05		346.54	
DIVERSION RESERVOIR	5.91	7.25	131.58		
WILLOW CREEK RESERVOIR	5.91	4.42	.85		
PISHKUN RESERVOIR	5.91	12.26	6.01		
SPLIT ROCK LAKE	5.91	4.12	25.41		
TUNNEL LAKE	5.91	9.96	99.29		
PISHKUN CANAL	5.91	12.16		88.16	
GIBSON RESERVOIR	6.57	4.07	4.32		
ABOVE GIBSON RESERVOIR	10.70	8.59		142.95	
WOOD LAKE	6.14	11.88	118.20		

1/ Parenthetical figures for trout only, others for all fish caught.

TABLE 14.--Comparison of the component parts of the average total expenditure per person per day for the North Fork Sun River and associated fisheries with other fisheries in the Missouri River Basin.

Fishery [1]	Average expenditure per person per day				Average round-trip mileage per person per day
	Annual	Investment	Trip	Transportation	
Ocean Lake, Wyoming, 1947-1949	$0.43	$1.12	$2.90	$4.77	68
Lake Maloney, Nebraska, 1949-1950	0.09	0.45	0.47	1.41	20
Republican River, Nebraska & Kansas, 1951	[2] 0.09	[2] 0.45	0.17	1.09	15
Fort Peck Reservoir, Montana, 1948-1950	0.63	0.33	0.40	1.42	22
Pathfinder Reservoir, Wyoming, 1951	[3] 0.45	[3] 2.05	1.33	3.39	48
Alcova Reservoir, Wyoming, 1951	[3] 0.45	[3] 2.05	0.80	2.49	36
Fremont Canyon, 1951	[3] 0.45	[3] 2.05	0.59	3.40	49
NORTH FORK SUN RIVER & ASSOCIATED FISHERIES, MONTANA, 1951					
BELOW GIBSON RESERVOIR	[3] 0.45	[3] 2.05	0.70	2.71	39
GIBSON RESERVOIR	[3] 0.45	[3] 2.05	1.89	2.18	31
ABOVE GIBSON RESERVOIR	[3] 0.45	[3] 2.05	5.33	2.87	41
WOOD LAKE	[3] 0.45	[3] 2.05	0.43	3.21	46

1/ See Table 13 for references.

2/ Applied from results obtained at Lake Maloney, Nebraska

3/ Applied from results obtained from a survey of Yellowstone County license holders (Fish and Wildlife Service, 1951c).

73 percent of the residents who used the area came from a radius of over 50 miles. Most of these people came from the prairie region east of the North Fork Sun River country. That these fishermen were willing to spend almost twice as much per day as those using the more accessible areas ($10.70 as against $5.91 to $6.57) to fish in a primitive setting is further evidence of the importance of such isolated fisheries.

Results of expenditure studies similar to those described for the North Fork Sun River and associated fisheries have been analyzed for three other cold-water fisheries and four warm-water fisheries. Results of these studies, together with those for this study, are shown in tables 13 and 14. There is considerable variation in the expenditure items listed in table 13, not only between the two types of fisheries (warm-water or cold-water) but within each of the types; nevertheless, on the basis of the data shown it appears that cold-water fishermen generally spend more per day to fish than do warm-water fishermen, and cold-water fish cost more per pound to catch than do warm-water species.

As is shown in the cited references and preceding sections of this report, the average expenditure per person per day is dependent upon a number of factors. Of these factors, that of miles traveled is the most important, as it in turn affects trip expenditures (table 14). As has been demonstrated in a study of annual and investment expenditures of Montana sportsmen (Fish and Wildlife Service, 1951c), expenditures for equipment are naturally higher for cold-water fishing. The average expenditure per pound of fish is affected not only by the total expenditure per person per day, but also by the rate of catch (both in numbers and in pounds of fish per hour). Expenditures per surface area of water or mile of stream are indirectly affected by the same factors as those affecting expenditures per person or per pound of fish.

SUMMARY

1. A study was made in 1951 of the fishing and yield of the North Fork Sun River and associated fisheries in Montana. Except for one check area, Wood Lake, estimates of fishing and yield were made for the period May 20 through September 30. Estimates for Wood Lake were made for the period June 24 to July 7 only.

2. Estimated fishing pressure and yield from approximately 80 miles of the North Fork Sun River (including two reservoirs which had a total surface area of 1,460 acres), during the period May 20 through September 30, 1951, was about 7,201 fisherman-days, and 14,755 fish weighing 6,728 pounds. Essentially all (99.8 percent) of the fish taken were game fish (trout, grayling, and whitefish). The average rate of catch was 0.52 fish per hour or 0.20 pounds of fish per hour.

3. Estimated fishing pressure and yield from approximately 3,100 acres of water in the associated fisheries, during the period May 20 through September 30, 1951, was about 2,976 fisherman-days and 1,546 fish weighing 2,155 pounds. The catch was composed of about 78 percent trout, grayling, and whitefish, 16 percent pike and yellow perch, and 6 percent suckers. The average rate of catch was 0.11 fish per hour or 0.16 pounds of fish per hour.

4. Estimated fishing pressure and yield from the 20-acre Wood Lake, during the period June 24 to July 7, 1951, only, was about 385 fisherman-days, and 494 fish weighing 199 pounds. The catch was 100 percent trout. The average rate of catch was 0.26 fish per hour or 0.11 pounds of fish per hour.

5. About 98 percent of the fishermen contacted during the study were residents of Montana, 72 percent of whom came from Great Falls, Montana, about 50 miles away. All but 7 percent of the fishermen came from within 100 miles of the study area. The importance of the wilderness area above Gibson Reservoir to nonlocal people is indicated. Fifty-five percent of all the nonresidents contacted during the study used this area and, exclusive of those who came from more than 300 miles away, 73 percent of the residents who used the area came from more than 50 miles away.

6. Results of the fisherman expenditure study indicated an average per-day expenditure of $6.27, with a range of $5.91 to $10.70 for various segments of the fishery. The average expenditure per pound of fish varied from $4.12 to $12.26 for the various segments of the fishery and averaged $7.41. The total annual value of the fishery is estimated to be $66,000.

7. The seasonal rates of catch for the streams were considerably higher than for the reservoirs. With minor exceptions, the rates of catch in numbers and pounds of fish per hour for the water included in the study were lower than rates shown for many other midwestern streams, lakes, and reservoirs.

8. A comparison of expenditure information obtained during the North Fork Sun River study with that obtained on other studies indicated the importance of the radius of influence in determining expenditures and referable values.

LITERATURE CITED

Anonymous

1948 Fisheries investigations at Fish Lake, Utah, fishing season, 1947. Coop. Wild. Res. Unit, 2 pp. (Mimeo.)

1949a A summer study of the fishery of Strawberry Reservoir, Wasatch County, Utah, 1948. Utah Coop. Wild. Res. Unit Quarterly Activity Report, Jan.-Feb.-March 1949.

Borges, H. Milton

——— Results of creel census studies on several Arizona Lakes. Unpublished, tentative.

Fish and Wildlife Service

1950a An evaluation of the Ocean Lake Fishery, Wyoming, 1947-1949. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 15 pp. (Mimeo.)

1950b An evaluation of the Lake Maloney, Nebraska, fishery, 1948-1949. U. S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 10 pp. (Mimeo.)

1951a A two-year fishery investigation of the West Gallatin River, Montana, 1949-1950. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 42 pp. (Mimeo.)

1951b A two-year creel census, Deerfield Reservoir, South Dakota, 1949-1950. U.S. Fish and Wild. Ser., Mo. River Basin Studies, 26 pp. (Mimeo.)

1951c Annual and investment expenditures of Montana sportsmen, 1949. U.S. Fish and Wild. Ser., Mo. River Basin Studies, 35 pp. (Mimeo.)

1952a A one-year creel census and evaluation of the Republican River, Nebraska and Kansas, 1951. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 29 pp. (Mimeo.)

1952b Fish stranded by the closure of the Pishkun Supply Canal, North Fork Sun River. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 18 pp. (Mimeo.)

1952c A three-year fishery investigation, Fort Peck Reservoir, Montana, 1948-1950. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 49 pp. (Mimeo.)

1952d A one-year creel census and fisherman expenditure study, Alcova and Pathfinder Reservoirs, North Platte River, Wyoming. U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies, 43 pp. (Mimeo.)

1953 Creel census and expenditure study, Madison River, Montana, 1950-1952, U.S. Fish and Wild. Ser., Mo. Riv. Basin Studies. (To be published in 1954 as Special Scientific Report: Fisheries No. 126.)

Hasler, Arthur D., and D. S. Farner
1942 Fisheries investigations in Crater Lake, Oregon, 1937-1940. Journ. Wild. Man. 6(4): 319-327.

Hess, R. H., and W. D. Kelin
1946 1946 creel census report. Colo. Game and Fish Dept. (Mimeo.)

Holloway, R. C.
1949 Lake-management studies in Oregon. Trans. Am. Fish. Soc. 77(1947): 104-113.

Lyall, Wildred A.
1941 Problems of fish management on Grand Mesa National Forest in Colorado. Trans. 5th No. Am. Wild. Conf.: 252-255.

Needham, P. R., and E. P. Cliff
1944 Anglers' catches from portions of certain Michigan trout streams in 1939 and 1940, with a discussion of indices to angling quality. Pap. Mich. Acad. Sci., Arts, and Lett. 29: 305-314.

Tarzwell, Clarence M.
1938 Factors influencing fish food and fish production in south-western streams (Arizona). Trans. Amer. Fish. Soc. 67(1937): 246-255.

Vestal, Elden H.
1943 Creel returns from hatchery trout in June Lake, California, Calif. Fish and Game 29(2): 51-63.

Wales, J. H.
1946 Castle Lake trout investigations. First phase: Interrelations of four species. Calif. Fish and Game 32(3): 109-143.

Wright, Stillman
1943 Some unregarded factors in creel census studies. Trans. 8th No. Am. Wild. Conf. :387-392.

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